MULTIMEDIA UNIVERSITY®

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2015/2016

PPH0105 – MODERN PHYSICS & THERMODYNAMICS

(Foundation in Engineering - All Sections / Groups)

30 MAY 2016
9.00 a.m – 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **FIVE** printed pages, excluding the cover page and appendixes, with **FIVE** questions.
2. Answer **ALL** questions. The distribution of the marks for each question is given.
3. Write all your answers in the Answer Booklet provided.
4. All necessary workings **MUST** be shown.

ANSWER ALL QUESTIONS

QUESTION 1 (10 Marks)

a) A wave traveling to the left on a string is given by the two snapshots of the wave, at $t = 0$ and $t = 0.05$ s, in **Figure Q1**. Write the equation for this travelling wave.

(5 marks)

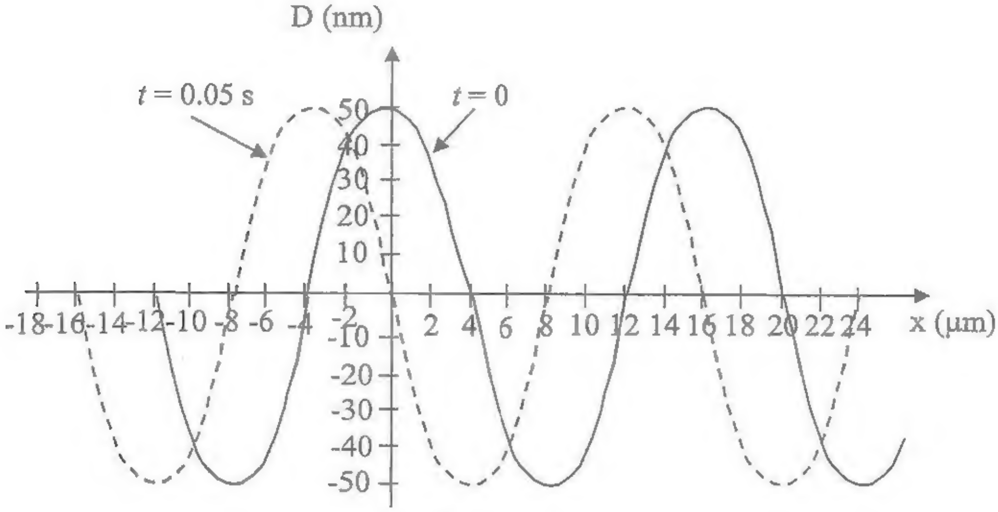


Figure Q1

b) A ringing bell delivers about 1 mW of power, which is assumed to be uniformly distributed in all directions.

i. What is the intensity at a distance 2.5 m from the bell?

(1 mark)

ii. What is the corresponding intensity level at that point?

(1 mark)

iii. What would be the intensity level at the same point if two identical ringing bell very close to each other are ringing?

(1 mark)

c) Define Doppler Effect for sound.

(2 marks)

Continued...

QUESTION 2 (10 Marks)

a) Red light of wavelength 640 nm passes through a slit 0.350 mm wide. The diffraction pattern is observed on a screen 3.00 m away. What is the width of the central bright fringe?

(2 marks)

b) **Figure Q2.1** shows an interference pattern of a Young double slit experiment formed on a screen. The wavelength of light used is 660 nm. Point Q is directly opposite a point midway between the two slits.

Figure Q2.1

i. Determine the path length difference of the lights that reach the screen at points P and R?

(2 marks)

ii. If light with shorter wavelength is used, will the number of fringes observed on the screen increase of decrease?

(1 mark)

c) The focal length of thin lens shown in **Figure Q2.2** is 30 cm. A screen is placed 120 cm from the lens. What is the y coordinate of the point where the light ray shown hits the screen? The incident ray is parallel to the principal axis(dashed line) and 1.5 cm from that axis.

(3 marks)

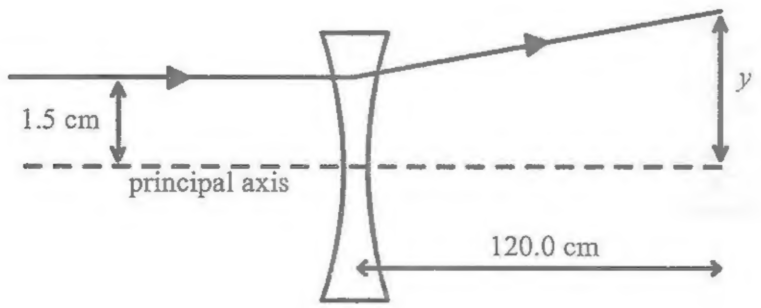


Figure Q2.2

Continued...

d) An object is placed 10 cm in front of a thin lens. An upright, virtual image is formed 30 cm away from the lens.

   i. What is the focal length of the lens?

   (1 mark)

   ii. Is the lens converging or diverging?

   (1 mark)

QUESTION 3 (10 Marks)

a) In photoelectric effect experiment, electrons are ejected from a metallic surface with speeds in range up to 6.21×10^5 m/s when light with a wavelength of 515 nm is used.

   i. Calculate the work function (in unit of eV) of the surface.
   ii. Determine the cutoff frequency of this surface.

   (5 marks)

b) A hydrogen-like atom, the triply ionized beryllium, has the atomic energy levels and its three transitions labelled as **A**, **B** and **C**, shown in **Figure Q3**.

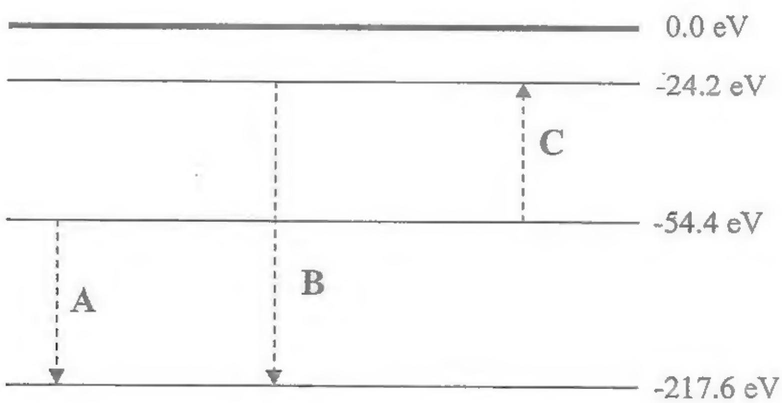


Figure Q3

   i. List transition(s) that absorb energy and that emits energy.

   (1.5 marks)

   ii. Determine the corresponding wavelength for the transition **B**.

   (2 marks)

   iii. Calculate the ionization energy required to set free the last electron from ground state.

   (1.5 marks)

Continued...

QUESTION 4 (10 Marks)

a) State the different penetrating ability of the three types of radiations: alpha, beta and gamma particles.

(3 marks)

b) A radioactive source is placed in a lead block as shown in **Figure Q4**. Copy the diagram and sketch the path of the alpha, beta-minus and gamma particles as it exit the radioactive source into a magnetic field directed out from the paper. From the sketch what can you deduce the charges carry by each of the particle?

(3 marks)

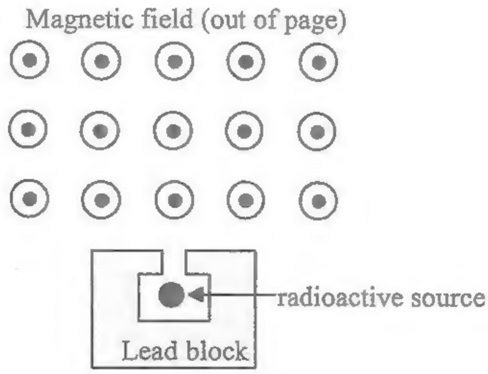


Figure Q4

c) Define half-life. (1 mark)

d) Measurements on a radioactive sample show that its activity decreases by a factor of 5 during a 2-hour interval.

i. Determine the decay constant of the radioactive nucleus.
ii. Calculate the value of the half-life for this isotope.
iii. If the sample contains 3.0×10^{16} such nuclei at $t = 0$, determine its activity at this time.

(3 marks)

Continued...

QUESTION 5 (10 Marks)

a) The temperature of a room is measured to be at 30 °C. Find the values of the room temperature in Fahrenheit and Kelvin scales.

(2 marks)

b) A window has a glass surface of 1.6×10^3 cm^2 and a thickness of 3.0 mm. Find the rate of energy transfer by conduction through this pane when the temperature of the inside surface of the glass is 70 °F and the outside temperature is 90 °F.
(Given: Thermal conductivity of glass, $k_{glass} = 0.84$ Js^{-1}m^{-1}°C^{-1})

(3 marks)

c) Two moles of an ideal gas in a metal container undergoes a thermodynamic process shown in **Figure Q5**. *BC* is an isothermal process. Calculate

a. the temperature of the gas at *A*.

(1 mark)

b. the temperature of the gas at *B*.

(2 marks)

c. the pressure of the gas at *C*.

(2 marks)

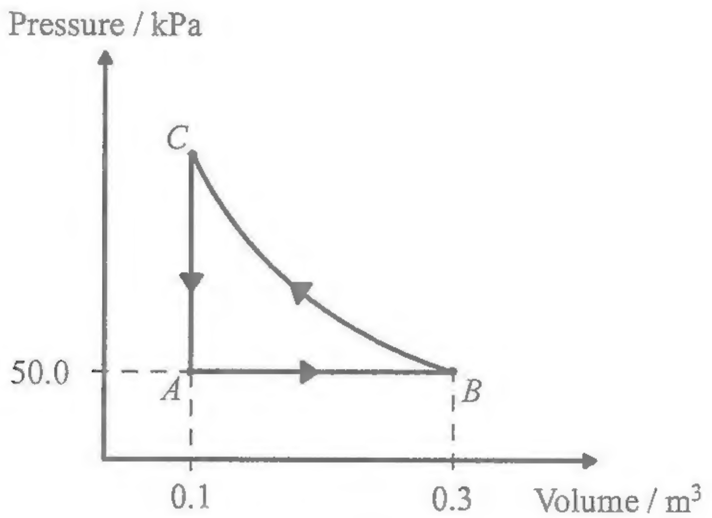


Figure Q5

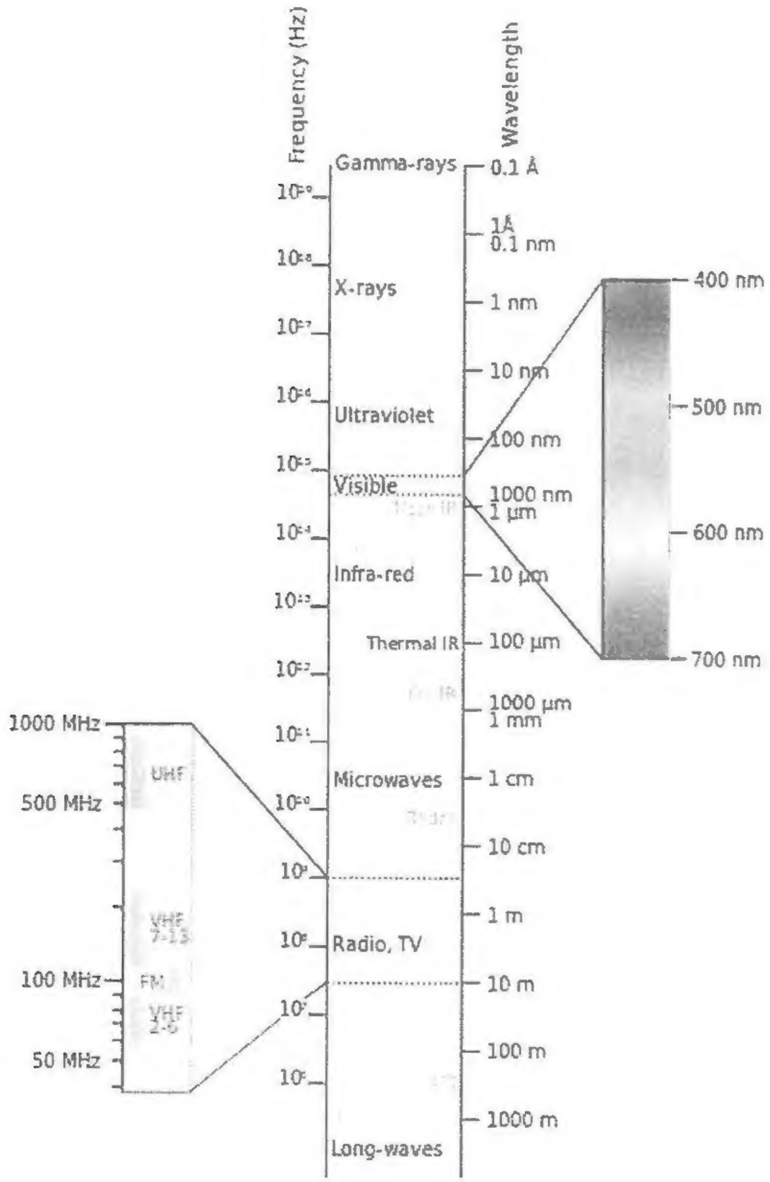
End of Page

APPENDIX I
LIST OF PHYSICAL CONSTANTS

Electron mass,	m_e	=	9.11×10^{-31} kg
Proton mass,	m_p	=	1.67×10^{-27} kg
Neutron mass,	m_n	=	1.67×10^{-27} kg
Magnitude of the electron charge,	e	=	1.602×10^{-19} C
Universal gravitational constant,	G	=	6.67×10^{-11} N.m^2 / kg^2
Universal gas constant,	R	=	8.314 J/mol.K
Hydrogen ground state,	E_0	=	13.6 eV
Boltzmann's constant,	k_B	=	1.38×10^{-23} J/K
Compton wavelength,	λ_c	=	2.426×10^{-12} m
Planck's constant,	h	=	6.63×10^{-34} J.s
		=	4.14×10^{-15} eV.s
Speed of light in vacuum,	c	=	3.0×10^{8} m/s
Rydberg constant,	R_H	=	1.097×10^{7} m^{-1}
Acceleration due to gravity of earth,	g	=	9.80 m/s^2
1unified atomic mass unit,	1 u	=	931.5 MeV/c^2
		=	1.66×10^{-27} kg
1 electron volt,	1 eV	=	1.60×10^{-19} J
Avogadro's number,	N_A	=	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing,	I_0	=	1.0×10^{-12} W/m^2
Coulomb constant,	$k = \dfrac{1}{4\pi\varepsilon_0}$	=	9.0×10^{9} N.m^2 /C^2
Permittivity of free space,	ε_0	=	8.85×10^{-12} C^2/N.m^{-2}
Permeability of free space,	μ_0	=	$4\pi \times 10^{-7}$ T.m/A
1 atmosphere pressure,	1 atm	=	1.0×10^{5} N/m^2
			1.0×10^{5} Pa
Wein's displacement constant		=	0.2898×10^{-2} m.K
Speed of Sound in Air		=	343 m/s
Refractive index of air/vacuum	n	=	1.0
Earth: Mass,	M_E	=	5.97×10^{24} kg
Radius (mean),	R_E	=	6.38×10^{3} km
Moon: Mass,	M_M	=	7.35×10^{22} kg
Radius (mean),	R_M	=	1.74×10^{3} km
Sun: Mass,	M_S	=	1.99×10^{30} kg
Radius (mean),	R_S	=	6.96×10^{5} km
Earth-Sun distance (mean),		=	149.6×10^{6} km
Earth-Moon distance (mean),		=	384×10^{3} km

APPENDIX II

THE ELECTROMAGNETIC SPECTRUM



APPENDIX III

LIST OF FORMULAS

$\sin\theta_1 + \sin\theta_2 = 2\sin\frac{1}{2}(\theta_1+\theta_2)\cos\frac{1}{2}(\theta_1-\theta_2)$

$\cos\theta_1 + \cos\theta_2 = 2\cos\frac{1}{2}(\theta_1+\theta_2)\cos\frac{1}{2}(\theta_1-\theta_2)$

$\sin\left(\theta+\frac{\pi}{2}\right) = \cos\theta$

$\sin\theta \approx \tan\theta \approx \theta$ *rad* for small angle

$D(x,t) = D_M \sin(kx \pm \omega t \pm \phi)$

$v = \sqrt{\frac{F_T}{\mu}}$ $\qquad$ $v = \sqrt{\frac{\text{elastic property of the medium}}{\text{inertia property of the medium}}}$

$\lambda_n = \frac{2}{n}L$ $\qquad$ $f' = f\left(\frac{v \pm v_o}{v \mp v_s}\right)$ $\qquad$ $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$

$\frac{1}{f} = (n-1)\left\{\frac{1}{R_1} + \frac{1}{R_2}\right\}$ $\qquad$ $d\sin\theta = m\lambda$ $\qquad$ $d\sin\theta = \left(m+\frac{1}{2}\right)\lambda$

$\lambda_m.T = 0.2898\times10^{-2}$ $\qquad$ $I(\lambda,T) = \frac{2\pi c k_B T}{\lambda^4}$

$E_n = -\frac{mk^2Z^2e^4}{2\hbar^2}\left(\frac{1}{n^2}\right)$ $\qquad$ $r_n = \frac{\hbar^2}{mkZe^2}n^2$ $\qquad$ $L = mvr_n = n\hbar$ $\qquad$ $\hbar = h/2\pi$

$\frac{1}{\lambda} = R_H\left[\frac{1}{n_i^2} - \frac{1}{n_f^2}\right]$ $\qquad$ $\frac{1}{\lambda} = \frac{mk^2Z^2e^4}{4\pi c\hbar^3}\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$ $\qquad$ $\lambda = \frac{h}{p}$ $\qquad$ $\Delta E = hf$

$N = N_0e^{-\lambda t}$ $\qquad$ $R = R_0e^{-\lambda t}$ $\qquad$ $\lambda = \frac{\ln 2}{T_{1/2}}$ $\qquad$ $Q = (M_X - M_Y - M_\alpha)c^2$

$\Delta L = \alpha L_0\Delta T$ $\qquad$ $PV = nRT$ $\qquad$ $k = \frac{R}{N_A}$ $\qquad$ $Q = mc\Delta T$ $\qquad$ $Q = mL$

$\frac{\Delta Q}{\Delta t} = -kA\frac{\Delta T}{\Delta L}$ $\qquad$ $\frac{\Delta Q}{\Delta t} = e\sigma AT^4$ $\qquad$ $\frac{\Delta Q}{\Delta t} = IeA\cos\theta$

$\overline{KE} = \frac{1}{2}m\bar{v}^2 = \frac{3}{2}kT$ $\qquad$ $U = \frac{f}{2}nRT$ $\qquad$ $\Delta U = \frac{f}{2}nR\Delta T$ $\qquad$ $Q = \Delta U + W$

$W = \int dW = \int_{V_i}^{V_f} PdV$ $\qquad$ $W = P(V_f - V_i)$ $\qquad$ $W = nRT\ln\left(\frac{V_f}{V_i}\right)$